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Bioenergy & Bioeconomy, Status and Perspectives

*JRC-MIGAL Workshop,
Israel, December 2015*



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JRC Enlargement/Integration/ Neighbourhood Countries Programme

Report of the Workshop

Bioenergy & Bioeconomy Status & perspectives

Hagoshrim, Israel
(16-17 December 2015).

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Acknowledgements

This Report presents a Summary of the content of the European Commission Joint Research Centre (EC JRC)-Galilee Research Institute (MIGAL) Workshop on Bioenergy & Bioeconomy, Status & perspectives which took place at Hotel Hagoshrim, Israel (16-17 December 2015).

This Workshop was co-organised by J.F. Dallemand (EC JRC, Institute for Energy and Transport IET, Renewable Energies & Energy Efficiency Unit), Professor U. Marchaim (MIGAL Galilee Research Institute, Biotechnology and Regional Development Department) & N. Scarlat (EC JRC, Institute for Energy and Transport IET, Renewable Energies & Energy Efficiency Unit) .

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The Workshop documentation, including the presentations, is available on the CEREHA (Centre of Excellence for Research on Environment Health & Aging) web site at: <http://www.cereha.eu/Cereha/Templates/showpage.asp?DBID=1&LNGID=1&TMID=84&FID=1182&PID=0>

Abstract

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This event was part of the 2015 activities of the JRC Enlargement-Integration-Neighbourhood Countries Programme through which the JRC develops scientific and technical cooperation with non EU countries. In addition to Israel and the European Commission, participants (about 30 in total) came from research institutions or companies from Albania (Tirana University), the Former Yugoslav Republic of Macedonia (Skopje University), Italy (ENEA), the Netherlands (Twente University), Portugal (Lisbon & Aveiro Universities), Serbia (Novi Sad University) and Turkey (Ege University). This Workshop benefited from the support & participation of the EU Delegation in Tel Aviv and of Israel-Europe Research & Development Directorate (ISERD). This Workshop included Sessions on Water, Bioenergy, Bioeconomy and two Round Tables on project identification in the field of Water & Bioeconomy.

1. Introduction

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A. Levy (CEO MIGAL) presented the Galilee Research Institute activities. MIGAL is an interdisciplinary applied research organization. It acts as a technology accelerator whose mission is to advance discoveries from basic applied research into start-up companies. Its aim is to serve as an economic generator of regional and national significance.

The R&D ecosystem of MIGAL supports entrepreneurship, collaborations and encourages interactions between academia and industry, leveraging public and private sector resources to foster ties and encourage commercial growth. MIGAL combines academic research with commercial experience providing a bridge that enables its researchers to become entrepreneurs.

Research in the Galilee Research Institute encompasses a wide range of disciplines including biotechnology, chemistry, microbiology, immunotherapy, drug discovery, clinical nutrition, computer sciences with a specific enhanced focus on agriculture and environmental sciences. Research groups often work together and implement new and innovative approaches that produce sustainable solutions to important challenges.

The Galilee Research Institute is internationally recognized as a hub of agro-innovation. Its scientists hold a recognised expertise in plant-based platforms to produce therapeutic molecules, agrotechnology, chemical extractions, vaccines technologies and computational chemistry.

Regarding MIGAL vision, the Galilee Research Institute is leading the establishment of a hub with specific focus on AgroBiomedical, vaccine technology, environmental sciences and CRO in the Galilee. The Hub will serve as a home for applied researchers, agronomists, clinicians, CRO and regulatory experts, entrepreneurs, start-ups, growers and consumer companies specializing in "green technologies", functional foods, food supplements, nutraceuticals, novel botanical therapeutics and related agrotech technologies with special focus on natural products, metabolic engineering, vaccine and precision agriculture. The new hub is located in one of the world's most developed agro regions. Supported by strong national initiative, a new technology incubator of a national scope is going to be established beside the Galilee Research Institute.

The Renewable Energy Policy of Israel was presented by D. Lavee (Department of Economics and Management, Tel-Hai College and Pareto Group). In September 2015, the Israeli Government has set a goal to reduce CO₂ emissions to 7.7 tons per capita per year (by the year 2030). To meet this target, three main objectives were set to be met by 2030:

- Reducing electricity consumption by 17%,
- Reducing private vehicle mileage by 20%,
- Increasing energy production from renewable energy to 17%.

The economic value of reducing air pollution by renewable energy compared to the conventional methods is currently estimated at 2¢ per KWh and is expected to rise in the coming years. Beyond pollution reduction, renewable energy has a number of advantages for the Israeli market, including:

- Diversifying sources of energy for electricity production,
- Contributing to energy security,
- Decentralizing electricity production and reducing strategic threat,
- Enhancing competition with the Israel Electric company (IEC),
- Enhancing employment in the peripheral areas.

Alongside renewable energy advantages there are also several disadvantages, including high production costs, volatile production and massive consumption of land.

The Government's targets in the field of renewable energy include increasing renewable electricity production from 5% in 2014 to 17% in 2030. However, electricity production from renewable energy during 2015 was only 2% of the total electricity production in Israel. The Government allocated quotas for electricity production from renewable energies at 2,280 installed MW by 2020. Approximately 58% of the quotas are designated for solar energies, indicating the significant applicability of this technology in Israel. So far, approximately 633 MW of installed capacity licences and 1,556 MW installed conditional licences were distributed. Despite the established targets regarding renewable energy production for 2030, quotas for the different technologies for years 2020-2030 have not been set yet. Such a decision should take into account a number of constraints:

- Production costs,
- Reliability and volatility of electricity production for each type of technology,
- Available energy sources,
- Cost of connecting facilities to the power grid and developing transmission and distribution systems.

In Israel, renewable energy is promoted through three main measures:

- Investment in R&D,
- Tax benefits,
- Tariff regulation.

Despite the decrease in production costs of photo-voltaic facilities, the production costs of renewable energies remain higher than the production cost of IEC. In order to meet the Government's targets, several key barriers must be removed, as displayed in the Table below.

Barriers	Explanation	Ways to remove barrier
Regulatory instability	The most fundamental barrier is the frequent change in quotas and feed-in rate of renewable energies.	Approve rates in the early stages of the project to increase regulatory certainty.
Tax & Levy	Some of the levies imposed on the entrepreneurs are not recognized in the normative feed-in tariff set for the entrepreneurs.	Mapping the costs imposed on the entrepreneur and dismiss/acknowledge it in the feed-in tariff.
Lack of coordination between regulators	Renewable energy entrepreneurs need to work with many regulators and sometimes there is low coordination between them.	Create a regulatory mechanism for cooperation among the various regulators. Consolidating the PUA with the Ministry of Infrastructure might help.

Table 1: Renewable Energy challenges in Israel

As a conclusion, Israel has set ambitious goals for promoting renewable energies. So far, renewable energies penetration to the market does not meet the target established. In order to meet the Government's targets the certainty for investors must be increased and the cooperation between various regulators promoted.

2. Session on Water

P.W. Gerbens-Leenes (University of Twente, The Netherlands) addressed the water footprint of electricity and heat.

The availability of fresh water of sufficient quality is an important issue on present policy agenda's, whereby the relation with energy security receives increasing attention. Today, fossil fuels (coal, oil and gas) are still the dominant energy source. In some countries, also nuclear energy is important. In 2012, 70% of the global electricity generation came from thermo-electric power plants, with 11% generated in nuclear power plants. The growing demand for energy and the need to reduce the use of fossil fuels to mitigate global warming has stimulated the expansion of renewable energy, e.g. hydropower and wind and solar energy. Biomass is another renewable energy source, providing fuels such as bioethanol or biodiesel, and also electricity when used in a power plant. Although renewables were often regarded as clean energy sources, there has been in the recent years an increasing concern about their environmental sustainability. Such concerns include for example the large amount of water use for growing biomass.

Water is essential to energy production. In the three stages of the energy production chain, the fuel supply stage, the construction stage and the operational stage, water is needed. In the fuel supply stage, mining, processing and transport of fuels like coal, oil, gas and uranium require water. The growth of biomass (e.g. firewood) for energy purposes also requires water. Other energy sources – hydropower and solar, wind and geothermal energy – do not have a fuel supply stage. In the construction stage, water is needed for the mining and processing of materials, for example, for the materials for a hydropower dam or for a power plant. In the operational stage, water is needed for processes like the cooling of power plants, dust suppression (e.g. for coal) or flue gas desulfurization. Also, there is water consumed through evaporation from the hydropower reservoirs or for the cooling of Concentrated Solar Power (CSP) systems.

A generally accepted indicator for water use is the Water Footprint (WF) that measures the volume of freshwater used for a product over the full supply chain, showing water consumption by source and polluted volumes by type of pollution. The blue WF measures consumptive use of surface and groundwater; the green WF measures consumption of rainwater (most relevant in agriculture and forestry); the grey WF, not considered here, is an indicator of water pollution. The term 'consumptive WF' is used to refer to the sum of the blue and green WF.

The goal of the study reported here is to estimate the present-day and future water consumption related to global electricity and heat generation and to understand determining factors, regional differences and risks posed by regional water scarcity. More specifically, the study aims:

- to quantify the consumptive WF of electricity and heat generation for different energy sources and technologies for the three main stages of the production chain, i.e. fuel supply, construction and operation, per unit of gross energy produced and per unit of net energy produced;
 - to assess the consumptive WF of electricity and heat generation per energy source per world region, accounting for the different energy mixes used per region;
 - to compare, per country, the fuel production (in TJ/y) and the operational WF of electricity and heat generation to the annual average monthly blue water scarcity in order to identify water-risk areas; and to estimate the consumptive WF in the year 2035.
- We consider the most important energy sources: coal, lignite, natural gas, shale gas, conventional and unconventional oil, uranium, biomass, wind, solar, geothermal and hydropower. The study is based on data from literature on water consumption per unit of energy for different energy sources, combined with information on electricity and heat production per energy source per country. The study identifies criticalities associated with water scarcity.

We emphasize that:

- we only consider the consumptive WF and that the grey WF falls outside the scope of the study
- we assume that power plants use freshwater for cooling. When power plants use seawater, for example in the case of Italy, where most fossil fuel fired power plants are located close to the sea, we overestimate the consumptive blue WF of electricity and heat.

The main results are presented and discussed below.

- Consumptive WF of electricity and heat for different energy sources, per unit of gross energy produced

The consumptive WF of electricity, expressed as the total volume of water consumed over the supply chain, per unit of gross electricity produced, primarily depends on the energy source. The renewables wind energy (0.2 to $12 \text{ m}^3/\text{TJ}_e$), solar energy from photovoltaic cells (PV) (6 to $303 \text{ m}^3/\text{TJ}_e$) and geothermal energy (7 to $759 \text{ m}^3/\text{TJ}_e$) have the smallest WFs. The renewables biomass and hydropower have the largest WFs, between $50,000$ and $500,000$ for biomass, and between 300 and $850,000 \text{ m}^3/\text{TJ}_e$ for hydropower. The WFs of electricity from fossil fuels and nuclear energy show similar ranges for the different sorts of energy. For coal we find a range of 80 to $2100 \text{ m}^3/\text{TJ}_e$, for lignite 90 to $1600 \text{ m}^3/\text{TJ}_e$, for conventional oil 200 to $1200 \text{ m}^3/\text{TJ}_e$, for unconventional oil 300 to $1800 \text{ m}^3/\text{TJ}_e$, for natural gas 75 to $1200 \text{ m}^3/\text{TJ}_e$, for shale gas 80 to $1300 \text{ m}^3/\text{TJ}_e$, and for nuclear energy 20 to $1450 \text{ m}^3/\text{TJ}_e$. The WF of Concentrated Solar Power (CSP) is in the same order of magnitude as the WF of electricity from fossil fuels and nuclear energy, because of the need for cooling.

In the case of electricity from fossil fuels and nuclear energy, the largest contribution to the blue WF is generally from the operational stage, in which water is lost through cooling. There are large differences in blue WFs for different cooling technologies. The largest blue WFs are found for wet cooling towers; smaller blue WFs are found for once-through systems using fresh water and again smaller WFs are found for dry cooling towers and once-through systems using saline water.

- Consumptive WF of electricity and heat per unit of net energy produced

For all sources of electricity, the Energy Return on Energy Invested (the EROI factor) is an important factor determining the WF of the net energy produced. In the case of fuels, there is also the conversion efficiency (from fuels to electricity) of the power plants, i.e. the Energy Required for Energy (the ERE factor). Improving energy efficiency in power plants (reducing the ERE factor) and reducing energy inputs in the supply chain as a whole (increasing the EROI factors) will contribute to the reduction of the WF per unit of net energy produced in the form of electricity and heat. For fuels with relatively small EROI values, like unconventional oil or shale gas (with EROI values of 3 to 4 , compared to an EROI value of 80 for oil or lignite), this means that WFs per unit of net energy provided are substantially larger than WFs per unit of gross energy output (e.g. 25% larger in the case of oil sand). In the case of renewables, particularly CSP has a low EROI value (1.6), which results in an increase of the WF from 120 - 2200 m^3 per TJ of gross energy to 300 - 5800 m^3 per TJ of net energy.

- The consumptive WF of electricity and heat per energy source per country

The total global electricity and heat of production was $89,076 \text{ PJ}_e/\text{y}$ (2008-2012). Coal and lignite contribute 41% to this total, natural gas 26% , hydropower 14% and nuclear energy 11% . The contributions of oil, firewood, wind, geothermal and solar energy are relatively small. The contribution of the different energy sources differs among countries, however, resulting in differences in WFs per unit of electricity. The global weighted average WF of electricity and heat is $4,241 \text{ m}^3/\text{TJ}_e$. When countries have a relatively large contribution of hydropower or firewood in the energy mix for electricity and heat, the WF is relatively large. WFs larger than the global average are found in countries like

Brazil, Argentina, India, Canada, Japan and many African countries. WFs below the global average are found in countries like the USA, China, the European countries (except for Austria, Finland, Hungary, Romania, Slovakia, Ukraine and the Baltic States), Australia, Russia, Mexico, Indonesia, Colombia and South Africa. The annual global consumptive WF for electricity and heat was 378 billion m³/y for the period 2008-2012. Europe has the largest WF (22% of the total), followed by China (15%), Latin America (14%), the USA and Canada (12%), and India (9%). The other countries contribute another 28%. The WF of China of 55 billion m³/y is dominated by firewood (83%), followed by coal and lignite (12%). In India, the WF of 33 billion m³/y is dominated by firewood (85%), followed by hydropower (10%). In Europe, the USA and Canada, the contribution of wood to the total WF was 39 and 51% respectively; the contribution of coal 4 and 9%; the contribution of nuclear power was 3 and 5%.

The global consumptive WF of electricity and heat of 378 billion m³/y is dominated by hydropower with a contribution of 49%, followed by firewood (43%). The dominant fuels for electricity and heat supply, coal and lignite, contribute only 5%, followed by nuclear energy (1.7%), natural gas (1%) and oil (0.6%). The contribution of the other renewables, wind, geothermal and solar is negligible. The global blue WF related to electricity and heat production (excluding the WF of electricity from biomass) of 217 billion m³/y is significant compared to the global blue WF of the agricultural, industrial and domestic sectors of 1,025 billion m³/y, which illustrates the significant role the power sector plays in putting pressure on the global freshwater system.

In general, the operation stage contributes most to the total WF of electricity and heat; the global average is 57%. In Latin America and Caribbean, this is even more (85%). The fuel supply stage contributes 43%, while the WF of the construction stage is negligible (0.02%). Electricity production contributes 90% to the total WF, heat production another 10%. Over the period 2000-2012, total energy production increased, resulting in increasing WFs. The global consumptive WF of electricity and heat in 2012 was 1.8 times larger than in 2000. The WF of electricity and heat from firewood increased four times, while the WF of hydropower grew by 23%.

- The consumptive WF of electricity and heat production in the context of water scarcity
Most countries within 5° to 35° northern latitude (most notably North African and Middle Eastern countries, Spain, Iran, Pakistan, India and Mexico) experience significant to severe water scarcity. About 28% of the global fuel is produced in countries with water scarcity above 100%, presenting a risk to the global fuel supply. About 46% of the fuelwood produced globally, 42% of the natural gas, and 30% of crude oil is produced in countries with blue water scarcity above 100%. Most relevant are the numbers for oil and gas, since they contribute about 25% and 31% to the global fuel supply, respectively. For coal, contributing 38% of the fuel supply, a relatively small percentage (14%) is produced in countries with blue water scarcity above 100%. About 22% of the global operational WF related to electricity and heat production falls in countries with blue water scarcity above 100%. Hydropower contributes about 86% to the total operational WF and 23% of this sector's WF occurs in countries with blue water scarcity above 100%.

As a conclusion, the consumptive WF of the electricity and heat sector can most effectively be reduced by moving towards greater shares of wind energy, energy from photovoltaic cells and geothermal energy. Even greater gains can be achieved with these forms of energy if greater energy returns on energy invested can be achieved through technological improvements. The consumptive WF of fossil-fuel based electricity can best be reduced by moving towards greater efficiencies in the power plants, by staying away from oil from bituminous sands, and shale oil and gas, and by moving towards dry cooling towers. Burning biomass in power plants leads to a major increase in the WF of electricity and heat; burning biomass grown for this purpose (firewood or crops) is not recommendable, but organic waste may be an option to be further studied. Hydroelectricity has a major contribution to the overall WF of the electricity sector and needs to be further evaluated case by case.

U. Marchaim (MIGAL) delivered a presentation on an integrated solution for Olive oil Mills' Wastewater. Olive oil Mills' Wastewater (OMW) corresponds to a global concern in many of the Mediterranean countries (Spain, Italy, Greece, France and Israel). Through the issue of treating OMW, based already on an initial work that was done in collaboration with EU partners (MISSTOW project), the aim is to implement a commercial solution. The innovative idea is to provide services thus the small enterprises in this field will not have to invest in a treatment plant at their facility. The system proposed associates the processes of settling and coagulation, anaerobic digestion to reduce the COD and the polyphenols compounds while producing biogas for use and the BAC technology of Bio-Aerated Cells. This process was studied at a pilot scale (over 3 m³ a day) for three harvesting seasons and was successful, but it had a retention time of over 5 days, determined probably by the mobility and regulation of transportation, which is not appropriate to treat several mills that produce much more OMW.



Part of the fermentation system on a platform

The main products from the process are recycled water for irrigation (if we reach the level according to the regulations) or water drained to the Wastewater Utility in the levels permitted, recycled wastewater to be used for irrigation, biogas that will be either used in a CHP to produce electricity and heat (both used at the Utility or nearby industries) or cleaned and compressed and used as Compressed Biogas (CBG) fuel for transportation, and compost as a fertilizer.

The combined solution proposed has never before been examined. Although based on research and several pilot scale experiences that showed that the bioreactors used are not able to give the services determined because of their limits in capacity and height, but can drastically reduce COD and phenols, this project aims to provide the short Hydraulic Retention Time (HRT) needed. Consistent with the regulations' core principles, it plans to follow all regulations requirements through its innovative approach.

The project will develop a demonstration full scale Stationary Central System and will examine an effective solution for the small olive mills in the partners' countries (planning at the first stage to build the plant in Southern Italy), guaranteeing a higher effectiveness of the approach. This concept is to be examined both by the Sewage Utilities and the olive oil mills' owners. The economic feasibility studies already performed were based on data derived from MIGAL experience with the mobile small system. It appears so far that if the olive mills would pay over 15 Euros per cubic meter the Stationary Central System feasibility would be ensured. This would correspond to an Internal Rate of Return (IRR) of about 11% with a payback time of around 5 years.

Through the thematic network and the local clusters, the best practices for the Mediterranean regions/countries will be disseminated in order to enhance the international image of the regions for investors. This project will lead to cross-border cooperation possibilities in RTD and innovation, support services that will spin-off from the work done. It will also establish the cross-border network that will deal with solutions in the future, building-up the discussions between oil producers, researchers and Water Authorities, all looking for solutions for OMW.

D. Dvoskin (Yanai Information Resources Ltd.) presented a preliminary economic assessment related to the regional treatment systems for Olive oil Mills Wastewater in Puglia, Italy. Small olive mills face an environmental challenge in the treatment of processing waste water. The work presented covers an economic analysis of a regional centre for the treatment of organic rich Olive oil Mills (OMW) wastewater effluents in Puglia, Italy. The proposed project is targeting the regional ecological and energetic problems and is based on research done in a pilot scale by MIGAL.

The proposed project is about:

- Establishing a relatively large regional facility collecting the wastewater in a regional reservoir near the facility,
- Pumping the wastewater from the reservoir to a wastewater settler. Collecting the screened wastewater in an intermediate tank,
- Treating the wastewater in the intermediate tank by a coagulation and flocculation process that causes the precipitation of the suspended solids,
- Separating the treated wastewater from the precipitate by pumping it through a second screen and into a second intermediate tank,
- Measuring the nutrients ratio and pH in the collected screened wastewater and adding nutrient(s) as needed,
- Pumping the nutrient-enriched wastewater from the intermediate tank into the first wastewater bio-aerated treatment container,
- Aerating the wastewater in each container through the set of perforated diffusers as needed;
- Heating the wastewater in each container if needed; and discharging the treated wastewater from a discharge conduit of the last container to the sewage system or to an irrigation system.

Regarding the summary of the economic analysis, the treatment of Olive oil Mills Wastewater is very challenging because the mills normally spread over large area, working only during the season and are relatively small. Still the environmental problem created by such mills, especially the contamination of ground water is very serious. A regional wastewater treatment is a solution but it is likely to require some cooperation between the private and the public sectors (PPP). The annual income of the stationary regional facility is around € 550,000 per year, most of it for tipping fee payment for the wastewater treatment and only 25% is from electricity sold and heat to be used on the WWTP. The annual cost is less than 65% of the annual income which means the project has an annual before-tax profit of more than 35%. The economic indicators (Net Present Value NPV, Internal Rate of Return IRR...) are relatively high, showing a positive outcome and attractiveness for an investor. All calculations were performed without taking into account subsidies that could be offered by governments, environmental agencies or other bodies.

A presentation was given by A. Halgoa (Saturas Company) about a Stem Water Potential (SWP) Sensor for Optimal Irrigation. Water is becoming scarcer and more expensive. With direct and reliable information on crop water status, farmers can save water and increase yields. Today, due to the lack of direct and reliable measurement, farmers typically overwater crops by up to 20% "just to be on the safe side." Overwatering puts pressure on an already scarce and expensive resource, increases pollution from nutrient rich runoff, affects the quality of the fruit, and reduces profitability. Stem water potential (SWP) is a scientifically recognized, accurate parameter for determining water status in

crops. Today, SWP can only be measured in a labor-intensive, manual procedure. Despite numerous approaches to sensor-based irrigation, including measuring soil and leaf moisture, the market lacks a solution that combines accuracy, ease of use and affordability. Saturas' miniature SWP sensor is embedded in the trunks of trees, vines, and plants. As part of an automatic irrigation system, this sensor provides accurate information for optimized irrigation to reduce water consumption and increase fruit production and quality. This precision agriculture sensing system comprises miniature implanted sensors, transponders and a control unit.

O.M. Shir (MIGAL Informatics, Computational Sciences and School of Computer Science, Tel-Hai College) gave a talk entitled "Search and Learning Capabilities in Agriculture and Water Sciences". This provided an overview Computer Science, Informatics challenges and problem-solving in the domains of Agriculture and Water Sciences. As data-mining problems and machine-learning tasks are increasingly acknowledged as having the capacity to play a larger role in active research in Natural Sciences, the three primary tasks in Systems Analysis were introduced, namely Modeling (Identification/Calibration), Simulation (Prediction/ Exploration) and Optimization (Control/Inverse Design). It was followed by the definition of Machine Learning (Supervised/Unsupervised). Certain aspects of search-space dimensionality, landscape nature and uncertainty in real-world data were also discussed and links were made to practical scenarios. To demonstrate such computational capabilities, two specific use-cases were presented (problem formulation followed by attained solutions):

- Classification of *Cercospora beticola* infections on a sugar beet leaf as a Supervised Learning problem,
- US-EPA's challenge on water quality monitoring as an Anomaly Detection problem.

As a summary, it was argued that addressing such challenges is possible in every research project and would be much desirable since it has the potential to give it an edge. Finally, the topic of multi-objective (Pareto) optimization was mentioned as a means to treat realistic problems with conflicting targets.

3. Session on Bioenergy

M.A. Coimbra (Aveiro University, Portugal) made a presentation on Research & Development on Brassica & International cooperation. The talk started with the presentation of BRASSICA Project (Reduction of BRASSICA waste by sustainable valuation of by-products). This Proposal was submitted to Horizon 2020 call 7-2015 (Waste: A resource to recycle, reuse and recover raw materials) under the Topic Ensuring sustainable use of agricultural waste, co-products and by-products. The main goal of BRASSICA Project Proposal was the valuation of nowadays Brassica agricultural wastes and industrial by-products into added valuable products, while reducing the environmental impact and implementing sustainable agricultural practices. It was retained that BRASSICA Proposal novelty was to explore ways of valorisation of the non-used parts of Brassica oleracea plants, namely inflorescences, leaves and stalks.

Four specific objectives were identified:

- Definition of sustainable agricultural practices allowing to exploit the whole aerial plant,
- Development of Brassica functional foods as an outcome of the extraction of bioactive compounds from non-used Brassica parts,
- Develop functional materials for food packaging, agronomic materials (mulching materials for pesticides and fertilizers delivery) and/or adsorbents (of water soluble pollutants and greenhouse gases),
- Definition of the best strategies to fully exploit the products containing bio-based compounds into the market, promoting a societal shift from the linear model of production and consumption of agricultural products into a circular one, where functional, healthy and affordable compounds can be derived from parts of the plants now considered as wastes.

The BRASSICA Proposal Consortium was composed of 20 partners from nine countries, including EU six Member States, two Associate Countries and a third country, China.

The second part of the talk was devoted to a presentation of the competences on polysaccharides chemistry and applications at the University of Aveiro:

- Development of chitosan-based films, as preservatives in wine to replace the addition of sulphur dioxide and with incorporation of grape pomace for food packaging applications,
- Bionanocomposites for food packaging, including starch-based films with high hygroscopic capacity and chitosan-graphene films with conductivity for in-pack Pulsed Electrical Field treatment of food;
- Sulphated polysaccharides from seaweeds and microalgae for biomedical applications as scaffolds and/or porous structures.

The presentation also included the description of the instrumental facilities and their application to different matrices for valuation of natural products and their by-products (on the route of bioactive compounds) and for monitoring food safety.

At the end of the talk, the FoodMater Project (Research, Education and Innovation in Materials for Food Science: An Integrative Approach Towards Food Sustainability”) was presented. This Project Proposal is under preparation for Marie Curie Actions (Innovative Training Networks ITN, Call H2020-MSCA-ITN-2016).

A. Golberg (Porter School of Environmental Studies, Tel Aviv University) delivered a talk on the global potential of off-shore macroalgal biorefineries to provide food, chemicals and energy, addressing feasibility and sustainability. Displacing fossil sources with renewables and increasing sustainable food production are among the major challenges facing the world in the coming decades. Integrating climatological oceanographic data with a metabolism and growth rate model on the example of the green marine macroalgae *Ulva*, the potential of offshore biorefineries to provide biomass, ethanol, butanol, acetone, methane and protein (globally and in 13 newly defined off-shore provinces) was analysed. It was shown that for optimum stocking density of 4 kg m² the total potential of off-shore cultivated *Ulva* macroalgal biomass is of the order of 10¹¹ dry

weight ton per year. It appeared that with the currently available processing and transportation technologies, the distance from the offshore farm to the shore is limited by transportation to 114-689 km, depending on cargo moisture content. The near-future technologically and economically deployable areas, associated with up to 100 m water depth and 400 km distance from the shore, can provide an order of 10^9 dry weight ton per year, which is equivalent to $\sim 18\text{EJ}$. This has the potential to displace entirely the use of fossil fuels in the transportation sector and to provide for 18% of predicted plant proteins demand in 2054. The environmental risks and benefits of large scale offshore macroalgae cultivation were also analysed. These results show the potential of offshore cultivation to contribute to the reduction of our dependence on fossil resources and arable land.

D. Noy (MIGAL Galilee Research Institute) delivered a presentation on the design and engineering of protein-pigment building blocks for solar energy harvesting systems. The design and construction of small protein functional analogs of photosynthetic proteins is an appealing route toward novel solar energy conversion devices for two important reasons. First, it provides simple models to the elaborate multi-protein multi-cofactor complexes that carry out natural photosynthesis. Thereby, it is a way to study the fundamental engineering principles of biological solar energy conversion and to learn how to implement these principles outside their biological context. Second, successful designs may be integrated with artificial and/or natural components into novel hybrid systems for the production of viable solar fuels. Our focus is on natural photosynthetic light-harvesting complexes in which dense arrays of chlorophylls, phycobilins and/or carotene derivatives are held in place by specific binding proteins. The particular arrangement of chromophores and their specific protein environment allows a precise control of the non-radiative energy dissipation processes that prevail in such dense arrays of pigments. This enables regulating the photon fluxes throughout the light harvesting system and directing excitation energy toward its final destination which is the reaction centre. The mechanisms underlying energy transfer and dissipation within the complicated network of chromophores in natural light-harvesting complexes are not completely clear. By designing small water-soluble proteins that are capable of binding and assembling a few chlorophyll and/or phycobilin derivatives, we are able to rigorously characterize energy transfer and dissipation mechanisms by systematic manipulation of pigment types, relative orientations and local protein environments. Recent examples include:

- the conversion of a native transmembrane chlorophyll binding motif into a water-soluble protein capable of binding up to seven bacteriochlorophyll derivatives,
- fusion proteins combining a natural phycobilin-binding protein domain and a de novo designed porphyrin- or chlorophyll-binding protein domain,
- a new reconstitution protocol for water-soluble chlorophyll binding proteins with native hydrophobic chlorophyll derivatives. From these we learn lessons on controlling photoexcitation dynamics in multi-pigment protein complexes.

4. Session on Bioeconomy

V. Motola (National Agency for New Technologies, Energy & Sustainable Economic Development, ENEA, Italy) made a presentation on Bioeconomy & Green Chemistry in Italy, challenges, projects and results.

In 2014, bioeconomy in Italy generated a 244 billion Euros turnover, representing a share of about 7.9 % of the national GDP and corresponding to about 4% share of the global bioeconomy export.

The National Technology Cluster of Green Chemistry (SPRING – Sustainable Processes and Resources for Innovation and National Growth) has the objective of triggering the development of bio based industries in Italy. This is intended to be achieved through a holistic approach to innovation and a revitalization of the Italian chemistry in the name of environmental, social and economic sustainability. The purpose is to stimulate research and investments in new technologies, in dialogue with local actors and to pursue the European Commission most recent targets on bioeconomy.

In this framework, there are several relevant industrial initiatives already in place. Novamont produces biodegradable plastic from biomass residues. For example, this innovation has helped the Municipality of Milan (2 million inhabitants) to reach a rate of 96% of Municipal Solid Waste separate collection, with the MSW organic fraction destined to biogas production and compost. In addition, the Novamont Matrica factory has been built inside a former chemical industrial unit, mostly in the decommissioning phase. It is an example of biorefineries rooted in the territory. Matrica development has permitted the cultivation of 400 ha of cardoon (*Cynara cardunculus*) using abandoned agricultural area in northern Sardinia (40 farmers involved). The full cardoon plant is exploited. The oil extracted from the seeds being used for bioplastic, the seeds proteins for animal feed, the cellulose from the plant stem for 2nd generation biofuels and the lignin for pellets.

Another example is the GFBiochemicals Biobased Chemical Company which started a commercial production at its 10,000 tons/year capacity levulinic acid plant in Caserta (Italy). The process is based on a reactor technology which allows feedstock flexibility, with a wide range of biomass categories able to be used, including cellulosic waste. GFBiochemicals also developed a new technology for the recovery and purification of levulinic acid. The continuous process produces formic acid and char which are recovered. This leads to a combination of high product yields, high productivity, concentrated process streams and efficient recovery. Levulinic acid is used to produce plastics, polymers, coatings, resins, agrochemicals and fuel additives.

The Mycoplast Biorefinery, located at 50 km from Milan, produces bio-polymers and bio-composites derived from the cultivation of fungi (mycelium) on agricultural residues. The products are biological, green and compostable and can be used for packaging material or for products for the agro-industries and bio-architecture. By implementing the adhesive and binding properties of the mycelium, this plant produces 100% natural bio-bricks which can be used for a number of different applications, such as thermal and acoustic insulation. In addition, the biomaterial obtained has physical characteristics and mechanical properties suitable for other applications such as furniture & vases.

Finally, the Proesa Bio refinery located in Crescentino near Turin, produces 40,000 tons of bioethanol/year (potential of 60,000 tons/year). The bioethanol is distributed in Europe and blended with petrol. The facility covers an area of 150,000 square meters and uses 270,000 tons/year of biomass (at maximum capacity). It also produces 13MW of electricity using lignin (process byproduct). In this way, it is totally self-sufficient with regards to its energy consumption. Water recycling is almost 100% and approximately 100 persons are employed.

H. Olgun (Ege University, Izmir, Turkey) gave a talk on Bioeconomy, status & perspectives in Turkey. The population of Turkey is estimated to be 78 million in 2015. Turkey is an important agricultural country where out of a total land area of 78 million hectares, 24 million hectares are used for agriculture, 14.6 million hectares for pastures/meadows and 21.5 million hectares for forests. 25% of the total population is employed in the agriculture. Turkey is located in three biogeographical regions: Anatolian, Mediterranean, Black Sea and their transition zones. Around 40 percent of the country's total land area consists of arable land. They are offering a wide range of products such as grains, pulses, oil seeds, fruits and vegetables, cut flowers, poultry, milk and dairy products, honey and tobacco. The forest area of 21.5 million hectares corresponds to 27 % of the overall land area, with 99 % of the forest being state owned. In addition to agriculture, forests have the potential to make a significant contribution to the development of the bioeconomy.

The Turkish economy is heavily dependent on imported energy supplies and its primary energy consumption is mainly based on fossil fuels. Turkey's energy policies and strategies are based on drivers such as energy supply security, alternative energy resources, diversity of energy resources, utilization of domestic energy resources to create additional value to the economy, liberalization of energy markets and energy efficiency. The Turkish Government has made it a priority to increase the share of renewable sources in the country's total installed power to 30 percent by 2023.

Bioeconomy is a quite new topic in Turkey. Bioeconomy is defined in Turkey as "a transdisciplinary economic activity which brings together economics and life sciences and interprets these on an engineering basis, also aims generating new theories in order to achieve more effective results. Conversion of agricultural products into high value-added products by technological production processes is considered as an opportunity in Turkish economy. The main aim is to convert the agricultural products into high value-added products by technological ways".

The National Bioeconomy Strategy is under preparation by the Ministry of Food, Agriculture and Livestock (General Directorate of Agricultural Research and Policy). The goal is to create a national strategy and action plan on bioeconomy. The strategy plan is not yet finalised but some activities (such as workshop and seminars) are being held. Other inputs are provided by the Ministries of Forest, Energy, Environment, Health and Universities. Regarding agriculture, the main 2023 targets of Turkey are to provide sufficient, best quality and safe food, to develop its net exporter position in agricultural products, to increase its competition power and to be a leader in agriculture (both at regional and worldwide levels).

Most of the bioengineering, food, health engineering departments of universities are interested in bioeconomy and several biotechnology innovative companies are already active in Turkey. Turkey has also skilled human resources on bioeconomy, industrial biotechnology, microbial biotechnology and genetic resources. Universities are conducting several research projects regarding all aspect of biotechnology/bioeconomy and implementing educational programs. Turkish Scientific and Technical Research Council (TUBITAK) funds basic and applied scientific research, PhD grants, organisation of scientific meetings, publications, and experts invitations on biotechnology.

<https://www.rvo.nl/sites/default/files/2015/10/Renewable%20Energy%20Turkey.pdf>

M. Martinov (Faculty of Technical Sciences, Novi Sad, Serbia) contributed on Bioenergy & Bioeconomy in Serbia, Status and Prospects, with a technical presentation prepared in collaboration with M. Viskovic (Same affiliation) and P. Canciani (Central European Initiative, Trieste, Italy).

The National Action Plan of Serbia for Renewable Energy Sources (RES), with focus on biomass, has been presented and discussed. The 2009 share of RES was 21.2 % of gross final energy consumption and in 2020 it should reach 27%. Biomass potential corresponds to about 60 % of total RES (about 3.4 Mtoe, with 1.1 Mtoe being now used). Although the potential of biomass seems to be overestimated, it still represents the largest reserve for further increase of the RES share.

According to the sectorial shares of RES, the total biomass contribution in 2020 is expected to be as follows: 33.6/7 % for electricity, 27.6/99 % for heating & cooling, 9.2/100 % for transport fuels (with a plan for transport to import about 60 %). The high share of RES electricity is based on hydro power and heating & cooling from biomass. The total increase of RES (2020 compared with 2009) is 621 ktoe with biomass from domestic sources contributing about 224 ktoe. The highest increase (267 ktoe) is planned for electricity.

Among the most significant remarks related to the RES National Plan, further to the assessment of the viability of the plan, it appears that the realisation of hydro power plants cannot be performed, due to long periods of planning and construction. Another difficulty is the report of low quality biomass used by heat generators, stoves and boilers, the low conversion efficiency (under 60 %) and high emissions of pollutants. The future of biodiesel is uncertain due to land use constraints and due to the RES Directive GHG savings thresholds.

Based on recently completed studies (two related to biogas and one to biofuels), regarding corn stover and biomass storage and in relation to a potential increase of biomass energy use, it appears:

- Crop residues and among them corn stover correspond to the largest unused biomass potential. There is a need to improve harvesting, storage and to overcome the high moisture content of biomass generally encountered. The use of corn stover, as well as other crop residues, is positive for land use and for GHG emissions savings. However, the preservation of soil fertility must be considered and performed.
- The use of crop residues as co-substrate for biogas production can increase the potential mobilization in medium size animal husbandry farms. This should be combined with a reduction of profitable biogas plant capacity, i.e. 150 kWe, or less, and the introduction of dry fermentation technology. This can contribute to about 35 ktoe of electricity and about 15 ktoe of thermal energy. Another possibility would be the generation of biomethane, which, produced from waste and crop residues, can be treated as Second Generation (2G) Biofuel.
- Corn stover, sole or in combination with other crop residues, can be used for the production of 2G Biofuel (lignocellulosic bioethanol, LCB). However, the minimum production capacity of a profitable LCB plant is estimated at 50,000 tons per annum. To achieve this production, there is a need of up to 250,000 tons of dry residual biomass. One plant of this type can produce about 35 ktoe of transport fuel with domestic resources.

It is concluded that international cooperation can boost progress in the RES production and utilisation.

O. Chukaliev (Faculty of Agricultural Sciences and Food, Ss Cyril and Methodius University, Skopje) addressed the status and perspectives of Bioeconomy in FYROM.

The idea that agriculture should contribute not only to food security but also provide biomass as a renewable raw material for industry and energy rise the dilemma about the intensification of agriculture and the soil, water and nutrient availability.

FYROM has a total area of 25 713 km² and a total population of about 2 million inhabitants. More than 50% of them live in rural areas. Agriculture is dominating the rural economy with 10-11% of the GDP. There are about 190,000 farm businesses, 80% of which are small size family properties of about 1.7 ha. The family farms employ about 440,000 members of households and 141,000 seasonal workers. Agriculture covers about 1.17 million ha and forest about 0.95 million ha. The natural environment for biomass productivity is not particularly favourable (frequent drought and heat waves, low fertile soils...) and this results in low crop yields (ex. 5-year average for period 2010-2014 winter wheat 3,11 t/ha, maize 4,32t/ha). The forest annual increment is about 2m³/ha. The country is a net importer of food and live animals.

Agriculture provides a significant amount of biomass waste that is underutilized. The largest amount of underutilized biomass is cereal straw (out of a total of 523.000 tons, 385.000 tons are required for livestock production and about 138 thousand- tons are not utilized). The biomass waste is estimated to be 125.000 tons for vegetables production, 27.000 tons for industrial crops, 13.000 tons for tobacco production, 62.000 tons for grape pruning and 30.000 tons for orchards pruning. Agriculture thus produces about 395.000 tons of biomass that is not utilized and could be used for energy production and other purposes. The present use of biomass is mainly related to firewood for heating (about 76% of the households, i.e. 430 000 use firewood for domestic heating). This makes biomass the most important renewable energy source. According to the State Statistical Office database on primary renewable energy production, biomass covers 57% of the total renewable production for the period 2005-2013.

It is therefore considered that biomass should be utilized more efficiently. There is slight progress in the production of electricity from biogas (two plants started in 2015 with a total installed capacity of 3 MW). But there is presently no electricity production from solid biomass (which according to the National Strategy for RES should reach 20 GWh in 2020).

The concept of bioeconomy is still not promoted in the country but there is a potential for its development if it will be encouraged through national policy and support measures. The most important measures should be:

- Investment in relevant research areas,
- Support to innovation to ensure that more of the knowledge developed reaches the commercialisation stage,
- Provision of a skilled workforce by making the various sectors of bioeconomy attractive career options through secondary and tertiary education,
- Improved two-way communication with the public. This should be embedded in R&D projects to ensure societal recognition of the role of research and innovation.

E. Rroço (Agricultural University of Tirana, Albania) delivered an input on the status and perspectives of Albanian agriculture and bioenergy. This input was prepared in cooperation with M. Banja (JRC Institute for Energy and Transport, Ispra). Albanian agriculture has experienced in the last few years a sharp increase of the production but the crop yields remain still much lower than the potentialities. The main constraints of the development of Albanian agriculture are the small average farm surface (1.13 ha) and the problem not yet resolved of land property. The main agricultural crops are cereals and forage crops. Nevertheless it has been evident in the last few years that there has been an increase in the last years in the cultivation of more labour intensive crops like vegetables, fruit trees and also aromatic plants. Inputs prices are higher than in neighbouring countries, having a high impact in the increase of the production costs. There are almost 500 000 cattle heads and 2.8 million of ovine heads in Albania but milk and meat yield are lower than the expectations. Agriculture exports are based on labour intensive crops like aromatic plants, vegetables and fruits, while the main imported agricultural products are wheat (and its products) and meat products. State subsidies for agriculture remain still limited.

The energy production in Albania is based mainly on hydropower and oil. The renewable energy production represents presently 31% of the gross final energy consumption in Albania. It consists mainly of hydropower produced electricity (63%) and wood for heating (33%). According to the First Albanian Renewable Energy Progress Report (2015), almost 4% (29 ktOE) of the final renewable energy in Albania consist of biofuels used in transport sector. The target for 2020 is a share of 38% of renewable energies in the gross final energy consumption.

Presently, there are no subsidies for bioenergy production in Albania. Due to the ongoing economic and production framework, the cultivation of energetic dedicated crops is not economically feasible. Forests are over exploited due to illegal cuttings and the forest fund has been decreased in the last decades. The Albanian Government approved on January 2015 a Memorandum on forest cutting that should reduce the use of forest

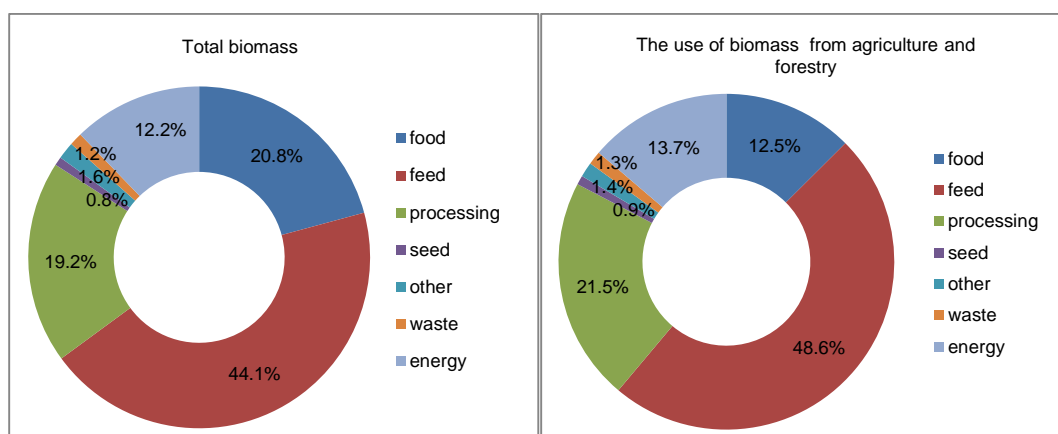
wood. This means that there are no real possibilities for increasing bioenergy production from forest woods for the future ten years. The main source for increasing bioenergy production consists of the use of residues of wood and olive processing residues, and also of the use of crop and livestock residues. Residues of wood and olive processing are currently used for heating through burning. The use of agricultural residues for bioenergy production is still underdeveloped. According to different studies, the potential of bioenergy production from agricultural residues amount to almost 120 ktoe. The most feasible bioenergy option is biogas production because of low investment costs. Due to the lack of subsidies and marketing facilities for bioenergy, biogas production for self consumption in Albanian farms remains at this stage the only real possibility. Bioeconomy is still a new concept in Albania. Steps towards integrated policies on environmental issues are undertaken through different agreements between the Environment and Agricultural Ministries. Further actions are needed on market, competitiveness and investments in research and innovation.

N. Scarlat gave a presentation on Bioeconomy from a European Union perspective. The European Commission has set a long-term goal to develop a competitive, resource efficient and low carbon economy by 2050 (COM(2011)112 final). As part of a green economy, the bioeconomy plays a key role, being able to replace fossil fuels on a large scale, not only for energy applications, but also for chemicals and materials. The Strategy and Action Plan for Innovating for Sustainable Growth: A Bioeconomy for Europe (COM(2012) 60) was "set to pave the way to a more innovative, resource efficient and competitive society that reconciles food security with the sustainable use of renewable resources for industrial purposes".

Regarding biomass use in the EU, the EU has a number of well-established traditional bio-based industries (agriculture, food, feed, fibre, pulp and paper and wood products, biofuels and bioenergy) and new ones are emerging (biochemicals, biomaterials, biopharmaceuticals). Bioeconomy is already one of the biggest and most important components of the EU economy. From the 2000 Mt biomass used in the EU in 2012, including agriculture, forestry, animal products and aquatic biomass, 21% was used for food, 44% for feed, 19% for processing and 12% for energy production. Biomass is used as feedstock, for example for wood based materials, pulp and paper production, biomass-derived fibres, and as biofuel feedstock (from oilcrops, starch and sugar crops).

	European Union
	[million tonnes]
Food crops	684
Fibre crops	0
Fodder crops	564
Crops	1,248
Crop residues	212
Agricultural biomass	1,460
Wood	290
Agriculture and forest biomass	1,750
Meat and animal products	200
Aquatic biomass	14
Total biomass	1,965

Table 2: Biomass supply in Europe and in the European Union in 2012
(Source Eurostat, 2014).



**Figure 1 : Use of biomass in the European Union in 2012
(Source Faostat, 2014).**

The EU wood-based industries cover a range of activities, including the furniture industry and pulp and paper production. The forest biomass potential was estimated at 747 million m³ per year in 2010 (under a medium mobilisation scenario) and 733 million m³ in 2030, but it ranges between 625 million m³ and 898 million m³ per year in different scenarios in 2030 (EUWood, 2010). Forest industry is a good example of the cascade use of wood; wood is used/reused several times in different processes. The total supply of woody biomass in the EU in 2010 was calculated at 994 million m³, considering forest biomass supply, wood residues and recycled material from wood products. Significant amounts of wood residues are generated and recycled across during wood processing, which are reused to produce various products (wood based materials, pulp and paper) and generate energy (Mantau, 2012).

Wood Biomass Potential Supply	2010	2020	2030
Forest	686	678	681
Wood	308	370	429
Total	994	1048	1110
Use			
Material	458	529	620
Energy	346	573	752
Total	804	1102	1372

**Table 3 : Wood biomass potential and the use of wood in the EU [million m³]
(Source EUWood, 2010, Mantau, 2012).**

Regarding biomass in the biobased industry in the EU, bio-based materials and bio-chemicals do not account yet for a high share of biomass use. For example, the chemical industry used about 8.6 Mt of renewable raw materials in 2011 in comparison with 90 Mt tonnes of feedstock used for various chemicals (See Figure). In the past, various materials (including plastics, solvents, lubricants, etc.) have been fully derived from oil products, but there is a significant expansion of the bio-based materials (See Figure 3) for various industrial applications. Biotechnology is likely to be widely used to develop new plant varieties, microorganisms or algae, to produce new

biopharmaceuticals and also to produce biochemicals, biopolymers, enzymes and biofuels.

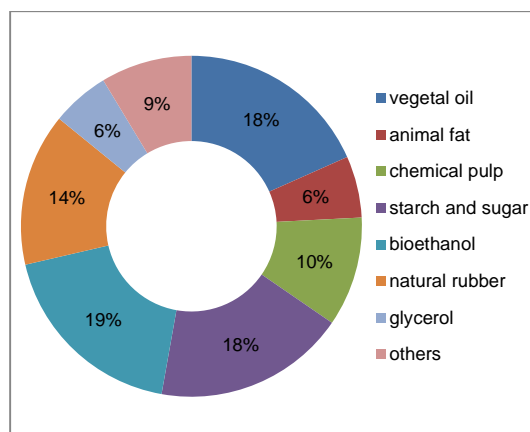


Figure 2 : Use of bio materials in the chemical industry in the EU (Source Cefic, 2014b)

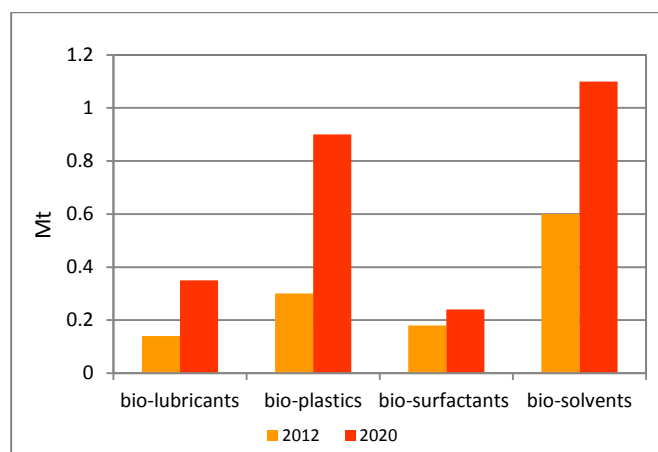


Figure 3 : Production of bio-based production in the EU

Regarding biomass in the biobased industry in the EU, bioenergy is the most important renewable energy source nowadays and it will continue to play a major role in energy supply as part of the energy and climate policies. Significant amounts of biomass (as firewood, wood chips, agricultural and wood residues) are used for bioenergy (electricity, heating and biofuels) production. Based on the data from the Progress Reports of the National Renewable Energy Actions Plans (NREAPs), we estimate that about 280 million tonnes biomass was used for bioenergy, of which 240 million tonnes biomass was used for heating and electricity production. The biomass demand for energy could increase to 420 million tonnes biomass until 2020. We estimate that about 40 million tonnes of biomass feedstock were used in 2012 to produce biofuels and this could increase to 63 million tonnes for food crop-based biofuels productions, based on the NREAPs. In addition, about 15 million tonnes of biomass (wood, straw, etc.) would be needed to produce lignocellulosic biofuels (Scarlat et al, 2015).

As for biomass potential and demand, the development of a bioeconomy will entail high demand for biomass not only for bioenergy, but also for bio-materials such as plastics that are presently derived from fossil sources. New bio-materials (bio-plastics, enzymes, biopharmaceuticals, etc.), which are now produced at reduced amounts, could have a

significant share in the materials demand in the future. Bioenergy is the most important renewable energy source nowadays with more than 60% and will continue to play a major role in energy supply, as part of the EU energy and climate policies. Biomass demand for energy purposes could increase to about 420 (378-439) Mt in 2030 and 432 (562-702) Mt in 2050, in the reference scenarios considered. In comparison with current potential of 438-728 Mt biomass in the EU, the biomass potential for energy use was estimated at 530-890 Mt for 2020 and 514-990 Mt in 2030.

The increasing biomass demand might be covered in the EU, but biomass mobilisation and competition between different uses (food, feed, fibre, bio-based materials and bioenergy) are key issues, depending on the costs. There are large uncertainties about the real available potential of biomass for different uses due to the competing uses and the application of various sustainability criteria. The conversion of a fossil fuel-based economy into a bio-based economy will probably be constrained by the overall limited availability of sustainable biomass in the EU. The EU might depend on the biomass import to provide biomass feedstock for the bio-based economy in the future. An increase in the bio-based economy is expected to be a worldwide development; therefore, only a part of the global biomass potential would be available for the EU.

	Present	2020	2030
Forestry	99-274	95-256	128-258
Agriculture	109-119	205-223	163-330
Waste	230-335	230-412	223-400
Total	438-728	530-891	514-989

Table 4 : Biomass potential for energy in the EU [million tonnes]
(Source: EEA, 2006, Elbersen et al., 2012)

Bioeconomy brings the opportunity to develop new biobased industries, open new markets for bio-based products and using resources more efficient and environmentally friendly. Shifting towards a bio-economy creates new business and innovation opportunities, in areas such as agriculture, forestry and industry. Nevertheless, the transition toward a modern bio-based economy implies challenges such as the sustainability of biomass raw material, efficiency in biomass use and economy of scales in biomass mobilization.

The following references are suggested:

- A Roadmap for Moving to a Competitive Low Carbon Economy in 2050, COM(2011)112 final, Brussels, 2011.
- Bioeconomy Strategy, Innovating for Sustainable Growth: A Bioeconomy for Europe, COM(2012) 60 Final, Brussels, 2012).
- Cefic, 2014. Landscape of the European Chemical Industry, The European Chemical Industry Council, 2014.
- EEA, 2006, European Environment Agency, How much bioenergy can Europe produce without harming the environment ? Report No7/2006 ISBN 92-9167-849-X2006, 2006.
- Elbersen B., Startisky I., Hengeveld G., Schelhaas M.J., Naeff H, Bottcher H., Atlas of EU biomass potentials. Spatially Detailed and Quantified Overview of EU Biomass Potential Taking into Account Main Criteria Determining Biomass Availability from Different Sources, Biomass Futures Project, 2012.
- Energy Roadmap 2050 (COM(2011) 885) .
- EUwood, 2010. Real Potential for Changes in Growth and use of EU Forests, TREN/D2/491-2008, 2010.
- Faostat,2014. <http://faostat3.fao.org/home/E>, 2014.
- Mantau U, 2012, Wood Flows in Europe (EU27). Project Report. Celle 2012.

- Scarlat N., Dallemand J.F., Monforti-Ferrario F., Nita V. The role of biomass and bioenergy in a future bioeconomy: Policies and facts, Environmental Development 15 (2015) 3–34.

4. Session on Uses of Biomass

V. Mathioudakis (Faculty of Engineering Technology, Water Engineering and Management, Enschede, Netherlands) contributed on the Water Footprint of agricultural waste and 2nd generation bioenergy. The increasing demand for energy contributes to accelerate resources depletion. Bioenergy has the potential to tackle the energy problem especially using the huge potential of second generation biomass. Biomass requires the consumption of water resources to grow and the sustainability of water consumption can be measured with the Water Footprint (WF) indicator. The WF includes the volume of freshwater used to produce a product, measured over the full supply chain. The WF consists of 3 components. The blue WF measures the consumptive use of surface and ground water; the green WF measures the consumption of rainwater and the grey WF is an indicator of water pollution. WFs are available for various entities like agricultural products, nations, bioenergy or energy carriers like for example bioethanol from corn.

The study presented calculates the WF of ten crop residues for the first time. These crops contribute to more than 60% of the global agricultural production. The WFs of miscanthus, eucalyptus and pine are included as well. Furthermore, the WFs of combustion, gasification, electricity by combustion, electricity by gasification, bioethanol and pyrolysis are calculated. Combustion is the chemical reaction of biomass and excess oxygen to release heat. Concerning gasification, reduced stoichiometric oxygen is used for the decomposition of the organic matter to produce heat and combustible gases. For the pyrolysis, the biomass is processed under complete absence of oxygen to produce the energy carrier bio-oil and heat. Fermentation is a biochemical conversion of biomass. The biomass is converted into sugars by enzymes and acids. The sugars are then fermented with yeast into bioethanol which is an energy carrier. An energy carrier is a substance that could be used to produce useful energy either directly or by several conversion processes.

The range of WFs of crop residues and miscanthus are 5 to 40 m³/GJ and for wood 67 to 74 m³/GJ. The WF of bio-oil ranges between 5 and 197 m³/GJ while the WF of bioethanol ranges between 7 and 545 m³/GJ. The WF of energy produced by combustion ranges from 5 to 91 m³/GJ and by gasification from 8 to 81 m³/GJ. The WF of electricity by combustion ranges from 33 to 158 m³/GJ and electricity by gasification ranges from 21 to 104 m³/GJ.

The results indicated very large WFs for miscanthus and it is suggested that miscanthus production for energy purposes should be halted. On the other hand, sugar cane bagasse WFs are very small. The WF of bio-oil is smaller than the WF of bioethanol. The WF of combustion or gasification is smaller than the WF of electricity. The smaller WF of heat is produced by combustion of cassava stalks at 5 m³/GJ. The smaller WF of electricity is produced by gasification of sugar cane bagasse at 21 m³/GJ. The results of this research contribute to the evaluation of the most sustainable or unsustainable ways of producing bioenergy in terms of water resources and give an outlook of the state of the art efficiencies or conversion factors (for energy carriers) of major conversion technologies related to bioenergy.

L.O. Martins (Institute of Chemical & Biological Technology, New University of Lisbon) gave a talk on the topic of White Biotechnology, addressing the use of biomass resources for chemicals, biofuels and materials production.

Biomass has emerged in recent years as an extremely attractive renewable source of chemicals, materials and fuels. It is widely believed that biomass abundance can facilitate the switch to a bio-based economy to replace the petrol-based industry that we have relied upon in the near past. However, the full development of sustainable biorefineries is critically dependent on an efficient separation of lignocellulosic constituents in the same way petrol refineries separate oil fractions to provide diverse fuels and materials. The presence of a lignin matrix, in the structure of the plant cell wall, where cellulose and

hemicellulose are immersed has been recognized as the main obstacle for cell wall deconstruction. Noteworthy, lignin is the most abundant aromatic polymer in nature, the second most abundant raw material next to cellulose but is currently burned for energy supply. Intensive research has focused in recent years on the conversion of lignin to high value chemicals and fuel precursors, using physico/chemical approaches including thermochemical and catalytic routes. However, currently, these strategies are not cost-effective and biocatalysis offers an environmentally friendly tool for lignin degradation, holding additionally the key for its successful valorisation.

The work performed and presented is based on the central hypothesis that the degradation of the complex, irregular and mostly insoluble lignin polymeric structure can only be sustainably addressed through the application of multiple enzymatic or chemo-enzymatic systems. Therefore, understanding the role and interaction of lignolytic and auxiliary enzymes in biomass degradation is urgently needed. This is especially valid if the aim is to predict and control reactions for the valorization of lignin and the production of added-value products. Furthermore the structural variability of cell wall in different plant species prevents the development of a generally applicable depolymerisation or valorization protocols. The ligninolytic potential of bacteria is much-less studied than that of fungi but it holds a higher potential considering the diversity of bacterial catabolic pathways involved in the mineralization of (lignin-derived) aromatic compounds in soil and the easiness of gene cloning, protein production and engineering.

In recent years we have successfully established a research program focused on the investigation of bacterial oxidoreductases, laccases and metallo-oxidases, from the family of multicopper oxidases and dye-decolourising peroxidases, a new microbial family of heme peroxidases, with potential application in the biorefinery field. The mechanistic and structural properties of the enzymes were thoroughly investigated in order to understand the basic determinants of their catalytic and stability properties. Multidisciplinary investigations demonstrate the efficiency of these enzymes for the degradation of synthetic and natural aromatic substrates, such as dyes or lignin model compounds, as well as for the synthesis of aromatic added-value compounds. Enzyme engineering, including directed evolution methodologies were optimized for the improvement of enzyme's performance and robustness. Our aim is to use the acquired knowledge and tools to set-up new multi-step (chemo) enzymatic processes to help in the degradation of plant biomass and the production of industrially relevant compounds, contributing for the creation of a circular economy and for the smart and efficient use of resources.

D. Levanon (Head of Agricultural Biotechnology Research Group, MIGAL) presented the SCOW (Selective Collection of the Organic Waste in tourism areas and valorisation in farm composting plants) project.

This Project addresses peripheral agricultural touristic areas and includes participants from the Palestinian Authority, Israel (Upper Galilee), Malta, Italy (Liguria), France (Corse), Spain (Catalonia). The main activities are the treatment of municipal organic waste by source separation, collection, transportation, composting, compost marketing and use.

This Project aims to the implementation of a quality selective collection scheme with:

- Treatment of the organic material in small, technologically simple farm composting plants, located mainly in agricultural holdings,
- Compost use in local agriculture, gardening, landscaping,
- Joint economic development of the service sector with an important agricultural activity and capitalisation of the project's results.

The role of each partner is:

- Sharing the results of the analysis of the regulatory framework,
- Analysing the potential transferability of good practices identified,
- Drafting a technical and policy proposal to improve the Mediterranean management systems,
- Cooperation with the associated institutions & networking activities.

The expected results include:

- A mainstreaming Action Plan for local and national policy makers,
- A transferability plan for local (private and public) actors,
- Establishment of a Mediterranean compost network.

This will be achieved through activities such as:

- Defining a mainstreaming action plan,
- Analysis of the regulatory framework at EU and PC level,
- Sharing of good practices, identified from the project partners and tested in other areas,
- Elaboration of specific proposals to improve the national and EU legislation on management systems for the selection and treatment of organic waste,
- Setting up a Mediterranean composting network.

MIGAL's involvement in this specific Project corresponds to:

- Responsibility for the communication and programs visibility,
- Support to partners and experts in composting and compost utilization,
- Monitoring the composting plants and preparing recommendations,
- Supervision of the model implementation in the regions.

5. Conclusion

During the Round table discussion on Water Recycling (Coordinator M.A. Coimbra, University of Aveiro, Portugal), the issues discussed were:

- Waste waters of domestic, industrial, agricultural origin,
- Use of purified effluents for agriculture according to quality standards,
- Problems related to sludge,
- Various treatment options, including the extraction of nutrients (N and P) to be used as fertilizers,
- Need to eliminate heavy metals and presence of hormones and antibiotics,
- Specific problematic wastes of the food and chemical industry,
- Potential re-use of enzymes from washing powders (detergents), namely lipases, proteases and oxidases,
- Microscopic glass particles in domestic waste waters, which blocks filtration membranes.

Based on the above mentioned issues innovative ideas should be further developed in research proposals. The suggested ideas were:

- Domestic effluents could contain active enzymes that can be used in further waste water treatments.
- Circular treatment of waste waters (where one waste category can serve for the treatment of other waste categories) should be implemented. For example, sludge can be converted into carbonaceous materials able to selective adsorb hormones and antibiotics. Ammonium phosphate could be selectively recovered by precipitation to be used as fertilizer.
- Flocculation of microscopic glass beads to promote their precipitation.
- Advanced strategies for monitoring effluents.

During the Roundtable on Bioeconomy (Coordinator N. Scarlat, EC JRC), the discussion areas were:

- Strict regulations and wastewater from cattle farms,
- Large amounts of wastewater resulting from olive oil production,
- Methods available to separate solids, systems to purify remaining water and reduce COD, BOD levels to acceptable limits,
- Impact of wastewater treatment on water footprint. Additional data are needed on water use for each process. In addition, there are different possibilities and options for each process, all requiring data on water use,
- Reduced levels of Phosphorus resources worldwide covering the needs for less than 100 years, therefore, recovery of Phosphorus from wastewater from animal farming could be a possible option,
- Use of water from wastewater treatment plants and from desalination plants to recover Fe and P,
- Reference to the BRISK (Biofuels Research Infrastructure for Sharing Knowledge) Project which has facilities which can be made available for research testing, individual R&D and funding to researchers to use the various laboratories,
- Test of steam explosion for biomass pretreatment, biomass gasification at ENEA Italy,
- Digestion of farm manure and silage maize in thermophilic conditions at high temperatures in opposition to mesophilic digestion,
- Poultry farms leading to high ammonia emissions,
- Possible use of enzymes and microorganisms to destroy antibiotics present in poultry manure.

The Project ideas discussed included:

- Enzymes for breaking down the antibiotics from farm manure,
- Systems to recover nutrients, P and Fe, from wastewater,

- Use of existing facilities for biomass (pre)treatment under BRISK II Project,
- Management of poultry manure (anaerobic digestion),
- Multi-country assessment of all (small) waste and residue sources and characterization of waste streams,
 - Assessment of the competitive uses of waste streams,
- Mobilization of different small waste streams,
- Use of enzymes to produce bio-materials,
- Bioconversion into new products/molecules,
- Anaerobic digestion of poultry manure,
- Biogas production and use of heat to dry sewage sludge (next to a wastewater treatment plant),
- Set-up of a Thematic Network on salt tolerant crops in arid areas and phytoremediation.

The following points emerged from the Workshop:

- Strong experience of MIGAL about the link between R&D activities & activities of local development (Green economy and employment, innovation, creation of innovative start-up or spin-off companies...),
- Wide experience in Israel on research and cultivation of crops (including citrus, avocado, mangos....) adapted to climatic ranging from arid to sub-tropical conditions, with genetic selection, advanced irrigation resulting in high yields and strong expertise about greenhouses operation, orchards, mushroom cultivation...,
- Practical solutions implemented in Israel in the field of the treatment of waste water from wineries or olive processing plants,
- Israel has now less than 2% of its work force in agriculture and 20% of the agricultural production originates from Galilee,
- Experience in Israel on technology and water services, water purification (irrigation, domestic effluents and drinking water) and equipment construction (mainly for export to Europe & the rest of the world, including Asia),
- Operational use of desalination plants in Israel. The use of water in agriculture corresponds roughly to 50% of the total use at country level, part of it being recycled or re-used. Desalination covers 37% of the needs, same figure for freshwater withdrawal,
- High energy needs for desalination plants, but it is not possible at this stage to cover the energy needs of large plants with renewable energy,
- Animal farming in extensive conditions sometimes more favoured by citizens but this implies different waste management practices and impacts the mobilisation of residues for bioenergy production,
- For future energy scenarios with a strong development of renewables, options with a large use of biomass for bioenergy have a higher water footprint (and also land footprint) compared to other renewable or non-renewable options. The inclusion of green water footprint (rainfall) in activities of comparison between energy options is to be further discussed and is not a field of consensus.
- Bioeconomy is a mosaic of different activities at various stages. Bioenergy in the EU corresponds to more than 50% of total renewables and this is expected to still be the case in 2020. Ongoing research on green biotechnologies, green chemistry and bio-materials (lower quantities of biomass used but with greater profit margin envisaged)
- Importance of fundamental research e.g. for white biotechnology, for example for medicine & human health applications,
- Technology improvements in the field of waste water treatment might be a viable option to improve the respect of environmental legislation,
- Research on waste management and implementation of good practices essential components for the development of a circular economy using less resources,
- Scientific & Technical cooperation must include strong multi country networks, including networks on topics such as phytoremediation for polluted/contaminated soils, use of plants for waste water treatment and cultivation of salt tolerant plants (All topics with experience in Israel and relevance for Mediterranean and semi arid/arid conditions),

- Need to clearly define or agree internationally on the terminology used especially for waste, residues, by products. Care should be taken about data analysis due to various definitions used. Need to improve the quantification of bioeconomy per sector/sub-sector at regional, national or multi-country levels,
- Technology & Innovation role in R&D or operational use of GIS based precision farming, precision irrigation, algae to energy...
- Essential role of public support tools for renewables (including bioenergy), links with public policy and economics of various energy options,
- Importance of the recovery of nutrients from waste water for possible use as fertilisers,
- Despite the wide ranging topic of this workshop and the heterogeneity of the countries (or institutions) represented in this Workshop (Netherlands, Portugal, Italy, Israel, Serbia, FYROM, Albania, Turkey...) common issues are to be faced in relation to bioeconomy and there is wish to develop common multi country projects in Horizon 2020 or other Programmes.

JRC Enlargement/Integration/ Neighbourhood Countries Programme

Workshop Motivation

*Bioenergy & Bioeconomy,
Status & perspectives*

Background

This Workshop is organised by the Joint Research Centre (JRC) of the European Commission (<http://ec.europa.eu/dgs/jrc/index.cfm>) and the Galilee Research Institute (MIGAL). This Meeting is an activity performed within the framework of the 2015 JRC Enlargement/Integration/Neighbourhood Countries Programme (<http://ec.europa.eu/dgs/jrc/index.cfm?id=1720>).

Within this Programme, the JRC develops a scientific and technical cooperation with non EU countries (Research organisations, public institutions, national laboratories, sectorial associations, companies...) which intends to facilitate scientific and technical exchange of data, information & expertise. It is proposed to hold this Workshop in Israel due to the fact that this country is an important player in the field of modern agriculture, water & waste management, biotechnology & bioeconomy. In addition to Israel, countries targeted in this Workshop and invited to participate are for example: Albania, Bosnia and Herzegovina, Former Yugoslav Republic of Macedonia, Moldova, Russia, Serbia, Turkey, Ukraine.

This Workshop is based on a concept of scientific networking used by the JRC on previous occasions in the field of biofuels or bioenergy, with the preparation of events such as:

- JRC-SECB-Ukraine Bioenergy Association-IEA Workshop on the *"Use of agriculture crop residues for bioenergy"*, Kiev, September 2014.
- JRC/Kurchatov Institute Workshop on *"International cooperation in the field of bioenergy"*, Moscow, October 2013.
- JRC/CER (Centre for Renewable Energy) of Chile on *"International Cooperation in the field of bioenergy technology"*, Santiago de Chile, March 2013
- JRC/CTBE (Brazilian Bioethanol Science & Technology Laboratory) Workshop on the *"Agro-environmental impact of biofuels and bioenergy"*, Campinas, December 2011
- JRC/INTA (National Agronomic Research Institute) Workshop on *"GHG emissions of biofuels and bioenergy"*, Buenos Aires, March 2011
- JRC/MPOC Expert Consultation on *"Direct and indirect impact of biofuels policies on tropical deforestation in Malaysia"* organised in Kuala Lumpur in November 2008 by the JRC and the Malaysian Palm Oil Council (MPOC).
- JRC/EEA/CENER Joint Seminar on *"Sustainable bioenergy cropping systems for the Mediterranean, Madrid"*, Spain, February 2006,
- JRC/CENER Expert Consultation on the *"Energy potential from cereals straw in the European Union"* 25, Pamplona, Spain, October 2006 ,
- JRC/EEA/Rothamsted Research *"Short Rotation Forestry, Short Rotation Coppice and energy grasses in the European Union: Agro-environmental aspects, present use and perspectives"*, Halpenden, United Kingdom, October 2007.

The Proceedings of these meetings are available on <http://iet.jrc.ec.europa.eu/remea>.

The JRC is also in charge of the Technical coordination of the European Biomass Conference (see <http://www.conference-biomass.com/>), a Member of IEA Bioenergy Task 43 on Biomass feedstock for energy use (see <http://www.ieabioenergytask43.org>) and has been coordinating in 2010-2013 the Bioenergy Module of EUROCLIMA Project of cooperation on climate change between the EU & Latin America.

This Workshop addresses international cooperation in the field of bioenergy and bioeconomy. It intends to focus on green biotechnology and bioeconomy in Israel, as well as on the status of bioenergy and bioeconomy in Europe (European Union, New Member States, Candidate Countries, Neighbouring Countries). Special attention will be

paid to the use of waste and residues (Municipal Solid Waste, agricultural residues, agro-industrial residues, residues from water treatment plants...) for bioenergy.

This Workshop is organised at JRC level by the REMM (Renewable Energy Mapping and Monitoring) Action of the JRC Institute for Energy and Transport (Renewable & Energy Efficiency Unit), (see <http://iet.jrc.ec.europa.eu/remea>).

REMM Action is contributing to the collection, harmonization and dissemination of EU-wide data on renewable energies availability, with a special focus on geographically referenced data for feedstock and resources (e.g. biomass, wind and hydro potentials). Such a knowledge is intended to be used as a basis for studying the actual exploitability of resources and its practical mobilisation. To achieve such a goal, other data are being collected, for example on energy and raw material transport infrastructure (e.g., natural gas grid for biogas, road network for biomass mobilization, electricity grid...) as well as data on costs corresponding to different steps of the renewable energies supply chain. Such an harmonized, interconnected collection of GIS layers and related data for renewable energy in Europe is expected to provide a quantitative basis for the monitoring of national strategies on renewable energies the European Union Member States are expected to undergo in next years. As an example, the REMM Action is involved in the analysis of the Progress Reports provided by the EU Member States for the monitoring of the National Renewable Energy Action Plans (with 2020 targets).

The REMM Action is a follow up of the BioS Action (Sustainability of Bioenergy) which aimed to provide robust information on the most important quantifiable parameters needed to formulate biofuels or bioenergy policy, such as:

- availability of feedstock from EU and world sources,
- energy balance,
- greenhouse-gas-balance,
- environmental impact,
- cost of production and mobilisation,
- potential in emerging countries,
- effect on commodity/food/by-product prices,
- competitive use and impact on existing industries,
- overall cost-benefit analysis.

The BioS Action was partly based on the experience gained with the joint JRC-CONCAWE-EUCAR (JEC) Well-To-Wheels (WTW) study on Life Cycle Analysis of biofuels. The JEC WTW study addresses energy balance, greenhouse-gas balance and costs of alternative fuels including biofuels. The REMM Action is also contributing to the quantification of the present situation of bioeconomy in Europe.

Israel partner

MIGAL description

MIGAL - Galilee Research Institute, founded in 1979, is a private applied research institute owned by the Galilee Development Company and located in Kiryat Shmona, Israel. Research at MIGAL is highly interdisciplinary and specialized in the areas of Agrotechnology, Environmental Sciences, Agriculture, Computer Sciences, nutrition science and Biotechnology. As a leading institute for applied research, MIGAL aims to strengthen and promote scientific innovation and spur economic growth. With over 65 Ph.D. scientists and a total staff of 190 researchers, engineers and students - all residents of the Galilee - MIGAL serves as focal point for economic and scientific developments as well as for science-community relations in the Galilee.

MIGALs' researchers collaborate with local, regional and international research organizations and universities, and maintain a high level of achievement and excellence, aiming to enhance economic opportunities for the local community and provide scientific and educational tools for students at the nearby Tel-Hai College, where MIGAL senior researchers serve as faculty members.

MIGAL scientists are involved in several international research projects/programmes such as FP6; FP7 (including ERC); ENPI..., bilateral such as BARD; BIRD, NIH as well as many national competitive projects. The water and wastewater sector is an important topic at MIGAL. Through its agricultural R&D, the Institute operates 10 extension stations across the Galilee, promoting knowledge and productivity to farmers and the agro-industry. MIGAL contributed significantly to the efficient use of recycled water for irrigation. Exposure of scientific activity to the community and incorporation of the local population in the scientific activity serves in strengthening the ties between the scientists and the Galilee communities. Raising awareness to scientific issues of children and young adults promotes the accessibility of scientific activity and brings to closer engagement with scientific issues.

The Institute has now two centres with laboratory facilities and offices and is responsible for managing research in 10 experimental farms all over the Galilee. It is well equipped in terms of laboratory space and infrastructure and is able to accommodate the latest technologies for experiments and analysis. MILOUDA Labs, operating from MIGAL, provide quality control laboratory services to the food sector, as well as laboratory services to the medical devices; cosmetics and environmental industries.

Motivation

EU Legislative Framework

The European Commission has approved on 23 April 2009 the Directive on the promotion of the use of energy from renewable sources (2009/28/EC) (http://ec.europa.eu/energy/renewables/index_en.htm).

The objective of this Directive (commonly called the RED Directive) is to establish a framework for the promotion of energy from renewable sources, with a view to achieving the European Union (EU) target of a 20% share of renewable energies by 2020.

EU Member States are required to achieve renewable energy production targets by 2020 in electricity, heating & cooling and transport. For pre-2004 Member States, these targets are to increase the share of renewable energies in these countries by about 6% to 13% compared to 2005 and, for Member States which joined in 2004 or afterwards, by about 5% to 10% compared to 2005. Intermediate trajectories are also laid down for each country. Moreover, Member States must ensure at least a 10% share of energy from renewable sources (i.e. biofuels but also hydrogen and electricity) in transport by 2020.

EU Member States were asked to draw up Renewable Energy Action Plans (RNEAPs), describing the measures they intend to take to achieve their respective targets and

specifying the split foreseen between renewable options. These plans were forwarded to the European Commission by 30 June 2010 and are being implemented.

According to the RED, biofuels and bioliquids must meet the following environmental sustainability criteria: a greenhouse gas emission saving of at least 35% with respect to the fossil fuel reference, calculated according to a method described in the Directive; absence of provenance from land with high biodiversity value (primary forest, nature protection area, highly biodiverse grassland) or with high carbon stock (wetlands, continuously forested areas, peatlands) and, in the case of European production, compliance with the environmental requirements applicable to direct aid under the Common Agricultural Policy (CAP). The emission savings requirements will rise in the future.

The European Commission also proposes a framework for verification of compliance with the environmental sustainability criteria, based on the use by economic operators of a mass balance system and on submission of reliable information by these operators to the Member State requesting it. EU Member States must report to the Commission on the promotion and use of energy from renewable sources by 2011 and then every 2 years. In addition to sustainability criteria for liquid biofuels (already covered by the RED Directive), sustainability criteria are being discussed for solid biomass. A cap for first generation biofuels has been introduced in order to address ILUC (Indirect Land Use Change).

In order to keep climate change below 2°C, the European Council and Parliament have set the objective of reducing Greenhouse Gas (GHG) emissions in the European Union (EU) by 80-95% by 2050, compared to 1990 levels. The *Roadmap for moving to a competitive low carbon economy in 2050* (COM(2011)112 final) set out key elements for the EU's climate action helping the EU become a competitive low carbon economy by 2050. The roadmap sets intermediate milestones for a cost-efficient pathway and GHG emission reductions, policy challenges, investment needs and opportunities in different sectors. The analysis of different scenarios indicates that a cost effective pathway requires a 40% domestic reduction of GHG emissions for 2030 compared to 1990 levels, and 80% for 2050. The energy sector should have an important contribution to achieving these goals, with a share of low carbon technologies in the electricity mix to increase from around 45% today, to 60% in 2020, 75 to 80% in 2030, and almost 100% in 2050 (EC, 2011b). The European Council *Conclusions on 2030 Climate and Energy Policy Framework* (October 2014) set a binding EU target of 40% domestic reduction in greenhouse gas emissions by 2030 compared to 1990, a binding target of at least 27% for the share of renewable energy in 2030 as well as a 27% energy efficiency indicative target.

Resource Efficient Europe, one of the seven flagships of the *Europe 2020 Strategy*, supports the shift towards a resource-efficient, low-carbon economy and to achieve sustainable growth. The *Roadmap for a resource-efficient Europe* (COM(2011) 571) sets a framework for the actions to develop a resource efficient, sustainable economy by 2050 and proposes ways to increase resource efficiency and decouple economic growth from resource use. It sets out a vision for the structural and technological change needed to achieve by 2050, with milestones to be reached by 2020.

The Europe 2020 Strategy calls for a bioeconomy within its Flagship Initiative 'Innovation Union' as a key element for smart growth and green economy in Europe. A new approach to advance EU research and innovation was the establishment of *European Innovation Partnerships (EIPs)* to speed up the development and deployment technologies to create the conditions for economic growth and social welfare. The agricultural European Innovation Partnership (EIP-AGRI) was also set to foster competitive and sustainable farming and forestry under the principle of 'achieving more and better from less' and to ensure a steady supply of food, feed and biomaterials.

Several EU policies and initiatives have an impact on the bio-based economy: agriculture, forestry, industry, energy, environment, climate change and research and

innovation. The first steps toward a bioeconomy have been made in 2002 when the *Life Science and Biotechnology Strategy* (COM(2002) 27), was released to develop and apply life sciences and biotechnology, setting out several actions for the development of biotechnology. The Strategy and Action Plan for “*Innovating for Sustainable Growth: A Bioeconomy for Europe*” aim “to pave the way to a more innovative, resource efficient and competitive society that reconciles food security with the sustainable use of renewable resources for industrial purposes” (COM(2012) 60 final). The strategy proposes an approach to address five societal challenges through the introduction of a bioeconomy: 1) ensuring food security; 2) managing natural resources sustainably; 3) reducing dependence on non-renewable resources; 4) mitigating and adapting to climate change; 5) creating jobs and maintaining European competitiveness.

This strategy aims to support better alignment of EU funding in research and innovation with the priorities of the bioeconomy. The Action Plan proposes the actions to be made for the development of bioeconomy markets along three directions: 1) promotion of research and innovation; 2) enhancing synergies and coherence between policies; 3) development of bioeconomy markets and competitiveness.

In addition to the EU strategy, several EU Member States (MS) have designed national bioeconomy strategies, which are linked through the Standing Committee for Agricultural Research (SCAR) to the European Commission.

A *Bioeconomy Observatory* was established to gather data and indicators to assess the progress of bioeconomy markets and socio-economic, scientific, technological, market and legislation impact.

Meeting scientific objective

The objective of this Workshop is to exchange expertise and information, collect/analyse/discuss data on bioenergy, green biotechnology & bioeconomy. For the part on bioenergy, it will target specifically the collection & use of waste (from agriculture and agro-industry, Municipal Solid Waste, water treatment plants...) for bioenergy uses. Of specific interest is the discussion of the experience in bioeconomy and bioenergy (resource assessment, objective & targets, policy framework, markets & sustainability) in Israel. Considerations about the status of bioeconomy in countries of Europe are also relevant.

The following topics are of special interest for this meeting:

- Resource assessment of waste & residues,
- Status & possible role of biotechnology & bioeconomy and integrated use of biomass (e.g. food, feed, fibre, fuel, biomaterials and green chemistry),
- Biogas production and use from residues or organic waste,
- Waste to energy conversion and environmental impact,
- Public support mechanisms or Public-Private partnership for bioenergy, development, biotechnology, or bioeconomy,
- Role of technology plans, renewables, bioenergy and bioeconomy roadmaps,
- Definition, implementation & monitoring of biomass sustainability certification schemes.

Space will be left to open discussions coordinated by a Chair Person and a Rapporteur in order to define, in the field of bioenergy & bioeconomy, which are the points of consensus or the technical fields where more research or international cooperation are needed.

This meeting will be performed in close cooperation with IEA Bioenergy Tasks 43 (Biomass feedstocks for energy markets) See <http://www.ieabioenergy.com>).

Communication language

English

Expected outcome

The outcome of this Workshop, including all presentations, will be made publicly available on the web site of the co-organisers.

Experts:

This Workshop is intended to include about 35 participants in order to allow interactive discussions (about 20 from Israel the host country, 5 from Enlargement & Integration & Neighbourhood countries, 5 from the European Union and 3 from the JRC). The experts from Israel will be invited by MIGAL - Galilee Research Institute as co-organiser. Experts will originate mainly from agricultural/environmental/technology institutes (including government agencies), renewable energy institutes, research centres and energy companies.

For this multi-disciplinary meeting, expertise of interest (in at least one of the following areas) is

- Bioenergy feedstock production or collection and conversion into energy,
- Bioenergy, bioeconomy & innovation Policies, cooperation between research, industry and SMEs, role and efficiency of public support mechanisms,
- Biogas production from different agricultural sources and sectorial uses,
- Integrated use of biomass resources for bioenergy and/or food, feed, fibre, biomaterials, green chemistry,
- Bioenergy & green biotechnology
- Environmental impact assessment of the collection & use of waste and/or residues for bioenergy use, especially regarding the impact on soil & water,
- Waste management,
- Quantification of GHG emissions from bioenergy (or other options) and Life Cycle Analysis of different pathways.

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JRC Enlargement/Integration/ Neighbourhood Countries Programme

Workshop Agenda

Bioenergy & Bioeconomy Status & perspectives

Hotel Hagoshrim, Israel
(16-17 December 2015).

ANNEX I. Programme

Tuesday 15/12/2015

Arrival of participants from Europe to the Galilee

Wednesday 16/12/2015

Time	Lecturer	Title of lecture
08:30	Registration	
	Greetings	
09:00	A.Levy - MIGAL Galilee Research Institute	
	A.Magal - Ministry of National Infrastructure, Energy and Water	
	J.F.Dallemand - European Commission Joint Research Centre	
	A.Kaniel - ISERD	
09:30-10:00	U.Marchaim, MIGAL Research Institute, Israel	<i>Description of the research activities at MIGAL</i>
Session I	Water	
10:00-10:20		<i>Application of life cycle approach: A key aspect of the sustainable infrastructure development</i>
10:20-10:40	Y.Yaacoby	<i>Mekorot, Advanced Demonstration Platform as a Critical Stage for Implementation</i>
10:40-11:00	G.Rytwo, MIGAL Research Institute & Tel-Hai College, Israel	<i>Clay polymer nanocomposites for the clarification of industrial effluents</i>
11:00-11:20	Y.Inbar	
11:20-11:40	E.Schossev, Peleg HaGalil	<i>Bio Aerated Cells for wineries' wastewater treatment</i>
11:40-12:00	P.W. Gerbens-Leenes, Faculty of Engineering Technology, Water Engineering and Management, Enschede, Netherlands	<i>Water Footprint of biomass for heat & electricity,</i>
12:00	Coffee Break	
12:30-12:50	U.Marchaim - MIGAL Research Institute, Israel	<i>Treatment of Olive Mills' Wastewater for producing biogas and water for irrigation</i>
12:50-13:10	D.Dvoskin - Yanai Co.	<i>Economics of waste recycling</i>
13:10-13:30	D.Lavi - Pareto	<i>Economic aspects in Israeli prospective</i>
13:30-14:30	Lunch	
14:30	Uses of Biomass	
14:50-15:10	O.Distel/A.Yefet - NewTech	<i>Current Trends in the Water Industry</i>
15:10-15:30	M.A. Coimbra, Department of Chemistry, University of Aveiro, Portugal	<i>Research & Development on Brassica & International cooperation</i>

15:50-16:10	D.Levanon – MIGAL Research Institute, Israel	<i>Use of mushroom for producing vitamins</i>
16:10-16:30	L. Martins, University of Lisbon, Portugal	<i>White Biotechnology (Use of Biomass Resources for chemicals, biofuels and materials production)</i>
16:30-17:00	Coffee Break	
17:00-17:20	V. Mathioudakis, Faculty of Engineering Technology, Water Engineering and Management, Enschede, Netherlands	<i>The water footprint of agricultural wastes and 2nd generation bioenergy</i>
17:20-17:40	E. Rroco, Agriculture University, Tirana, Albania	<i>Albanian Agriculture & Bioenergy, Status & perspectives</i>
17:40-18:00		
18:00	End of Day 1	
20:00	Dinner	Dag-Al-Hadan Restaurant

Thursday 17/12/2015

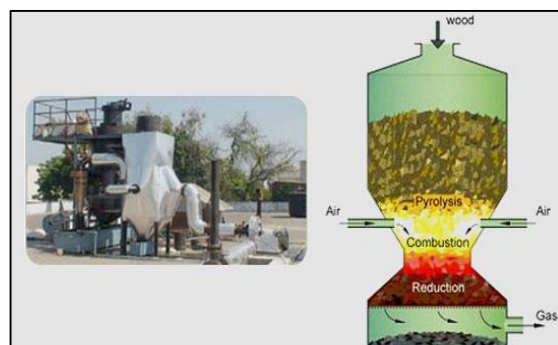
08:30-09:00	Registration	
09:00-09:20	J.F. Dallemand & U. Marchaim	Summary of the 1 st day.
	Bioeconomy	
09:20-09:40	N. Scarlat, European Commission Joint Research Centre	<i>Bioeconomy, a European Union perspective</i>
09:40-10:00	M. Martinov, Faculty of Technical Sciences, Novi Sad, Serbia	<i>Bioeconomy, status & perspectives in Serbia</i>
10:00-10:20	O. Chukaliev, Faculty of Agricultural Sciences and Food, Skopje, Macedonia	<i>Bioeconomy, status & perspectives in FYROM</i>
10:20-10:40	I.Zohar, MIGAL Research Institute, Israel	<i>Circular Economy</i>
10:40-11:00	H. Olgun, Ege University, Solar Energy Institute, Izmir, Turkey	<i>Bioeconomy, status & perspectives in Turkey</i>
11:00-11:30	Coffee break	
	BioEnergy	
11:30-11:50	A.Goldberg, Porter School of Environmental Studies, Tel-Aviv University	<i>Energy Efficient Biomass Processing with Pulsed Electric Fields for Bioeconomy and Sustainable Development</i>
11:50-12:10	D.Noy, MIGAL Research Institute, Israel	<i>Design and Engineering of Protein-Pigment Building Blocks for Solar Energy Harvesting Systems</i>
12:10-	Weitzman Institute	

12:30		
12:30-12:50	V.Motola, ENEA, Italy	<i>Bioeconomy & green chemistry in Italy, challenges , projects and results.</i>
12:50-13:10	I.Yaacoby, TAU, Israel	<i>Algal hydrogen production</i>
13:10-14:10	Lunch	
15:00-17:00	Round-Table discussions Organised in order to define, in the field of bioenergy & bioeconomy, which are the points of consensus or the technical fields where more research or international cooperation are needed. Presentation of the summary from the round table discussion by the rapporteurs.	
19:30	Farewell cocktail	

ANNEX II

Programme of the Study-Tour (Friday 18/12/2015)

- 08:00 Departure from Hagoshrim Hotel
- 08:20-08:50 Overviews on the Hula Valley and the drainage project
- 09:15-10:00 Visit of the Amiad Filtration Systems Factory
- 10:00-10:30 Travel to Dalton winery
- 10:30-11:30 Visit of the Dalton winery and the full scale Wineries' wastewater treatment Plant
- 11:30-12:15 Travel to Golani Junction
- 12:15-13:00 Lunch at Yunes restaurant
- 13:00-14:15 Travel to Rishon L'Zion, next to Tel-Aviv
- 14:15-15:30 Visit the Shafdan Complex of MEKOROT. Mekorot delivers the Shafdan reclaimed water to the south of the country. The effluent is recharged to the aquifer using a special technology (SAT). Mekorot pumps the reclaimed water and supplies it for agriculture in the NEGEV desert, according to the demand, enabling farmers to enjoy economic benefit as well. Many start-ups and pilots are located at the site.
- 15:30-16:15 Travel to Tel-Aviv.



JRC Enlargement/Integration/ Neighbourhood Countries Programme

Workshop List of Participants

Bioenergy & Bioeconomy, Status & perspectives,

Hagoshrim, Israel
(16-17 December 2015).

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Stimulating innovation
Supporting legislation*

